

### REMARKS

Applicants have amended the specification to correct minor grammatical errors. No new matter has been added. Entry of these amendments is respectfully requested. Figures 2-4 have been amended to insert the legend --Prior Art--. Support for this amendment is found, *inter alia*, on page 18, lines 7-12 of the instant application.

Claims 1-7 are currently pending in the application. Claim 1 is amended herein to further define the single crystal pulling chamber as having a crystal pulling region which vertically extends from the upper end of the crucible to a height that the upper end of the single crystal of metal fluoride to be grown reaches at the end of pulling, terminating at a location below the ceiling board.

Claims 1-7 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 3,359,077 to Arst (hereinafter "Arst"). Applicants respectfully traverse this rejection and request reconsideration in light of the amendment made to claim 1, taken with the following remarks.

Applicants point out that Arst represents a typical single crystal pulling apparatus of the conventional prior art as shown in Fig. 4 of the instant application, possessing shortcomings/problems which the present invention seeks to solve. In the single crystal pulling apparatus of Arst, in the chamber 10 of a growth furnace, a quartz crucible 31 is placed and the heater 13 is positioned around the crucible 31, as shown in Fig. 1 of Arst. Thermal insulation 12 is arranged so that the circumference of crucible 31 and heater 13 may be surrounded. An insulation cover 17 is provided on the upper part of the thermal insulation 12 so that an upper part of the heater 13 may be covered. A silicon melt 32 is accommodated in the quartz crucible 31 so that the seed crystal 43 at the tip of the single crystal pulling bar 42 is contacted by the molten silicon 32 in the crucible 31.

At the outset, it must be noted that the single crystal pulling apparatus of the present invention is for manufacture of a single crystal of a metal fluoride, while the single crystal pulling apparatus of Arst is for a single crystal such as of silicon. The apparatus for pulling a single crystal of a metal fluoride of the present invention is significantly different than the Arst silicon single crystal pulling apparatus.

Note in particular that the upper end of thermal insulation 12 where the insulation cover 17 is positioned is only at a slightly greater height than the upper ends of crucible 31 in the single crystal raising apparatus of Arst. In the case in which a single crystal of a metal fluoride is manufactured by using a conventional single crystal pulling apparatus such as Arst, there is a problem in that cracks are generated on the single crystal

being pulled, due to the fact that the crystal growth speed of the single crystal of metal fluoride is much lower than the growth speed of the single crystal of silicon or the like.

Therefore, when the single crystal pulling apparatus of Arst is used as a single crystal of a metal fluoride with an extremely slow speed of crystal growth, which is the object of the present invention, it is unavoidable that an unevenness arises in temperature distribution in the radius direction and in the height direction, while the slope of a temperature differential becomes large as the crystal is pulled into the region above the insulation cover 17 in Arst. The construction of Arst makes it difficult to raise the crystal slowly in a stable manner, resulting in thermally induced cracking of a metal fluoride single crystal which has been pulled up.

The reason for this result is that thermal insulation of Arst does not exist in the upper single crystal pulling region above cover 17 but, rather, a considerable opening exists between the crucible 31 and the single crystal raising bar 42. Thus, there is a great deal of thermal instability to be expected in the crystal pulling region above the cover 17 of Arst which causes faster cooling of the crystal being pulled up due to the lack of insulation.

On the contrary, with respect to amended claim 1 of the instant application, a single crystal pulling chamber 46 is surrounded by a heat insulating wall 26 and a ceiling board 44, wherein the single crystal pulling chamber comprises the single crystal pulling region 38 which vertically extends from the upper end of the crucible 20 to a height where the upper end of the single crystal 36 of a metal fluoride to be grown reaches at the end of pulling, terminating at a location below the ceiling board 44, wherein a coefficient of thermal conductivity in a direction of a thickness of the ceiling board is 1000 to 50000 W/m<sup>2</sup>K.

According to the single crystal pulling apparatus of the present invention defined in amended claim 1, the single crystal pulling region 38 is enclosed by the heat insulating wall 26 and the ceiling board 44. As a result, the single crystal pulling region 38 has an excellent heat retaining property particularly suited for pulling a single crystal of a metal fluoride which is very crack sensitive relative to thermal influences.

In addition, a material having the coefficient of thermal conductivity in the transverse thickness direction of 1000 to 50000 W/m<sup>2</sup>K is used as the ceiling board 44, resulting in the proper increase of heat radiation from the ceiling board.

Consequently, the single crystal pulling chamber is slowly cooled in a radial direction and a vertical direction. As a result, the nonuniformity of temperature distribution of the prior art, such as Arnst, is remarkably improved. Accordingly, in the single crystal pulling region 38, the single crystal is cooled slowly and uniformly during pulling so that a crystal

Appl. No. 10/717,018  
Amdt. dated June 23, 2005  
Reply to Office Action of 03-25-2005  
Attorney Docket No. 1217-032261

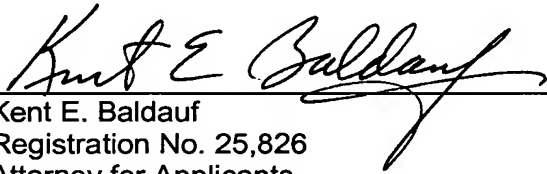
can be grown more stably. Even if the single crystal is a metal fluoride, such as calcium fluoride which has an extremely low crystal growth speed, it is possible to successfully suppress the generation of cracks.

Clearly, the Arst invention does not teach or suggest the structure and functions/effects of the present invention as defined in amended claim 1.

Pursuant to the above amendments and remarks, it is deemed that claims 1-7 are in condition for allowance, and the Examiner's favorable action is respectfully requested.

Respectfully submitted,

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**Amendments to the Drawings:**

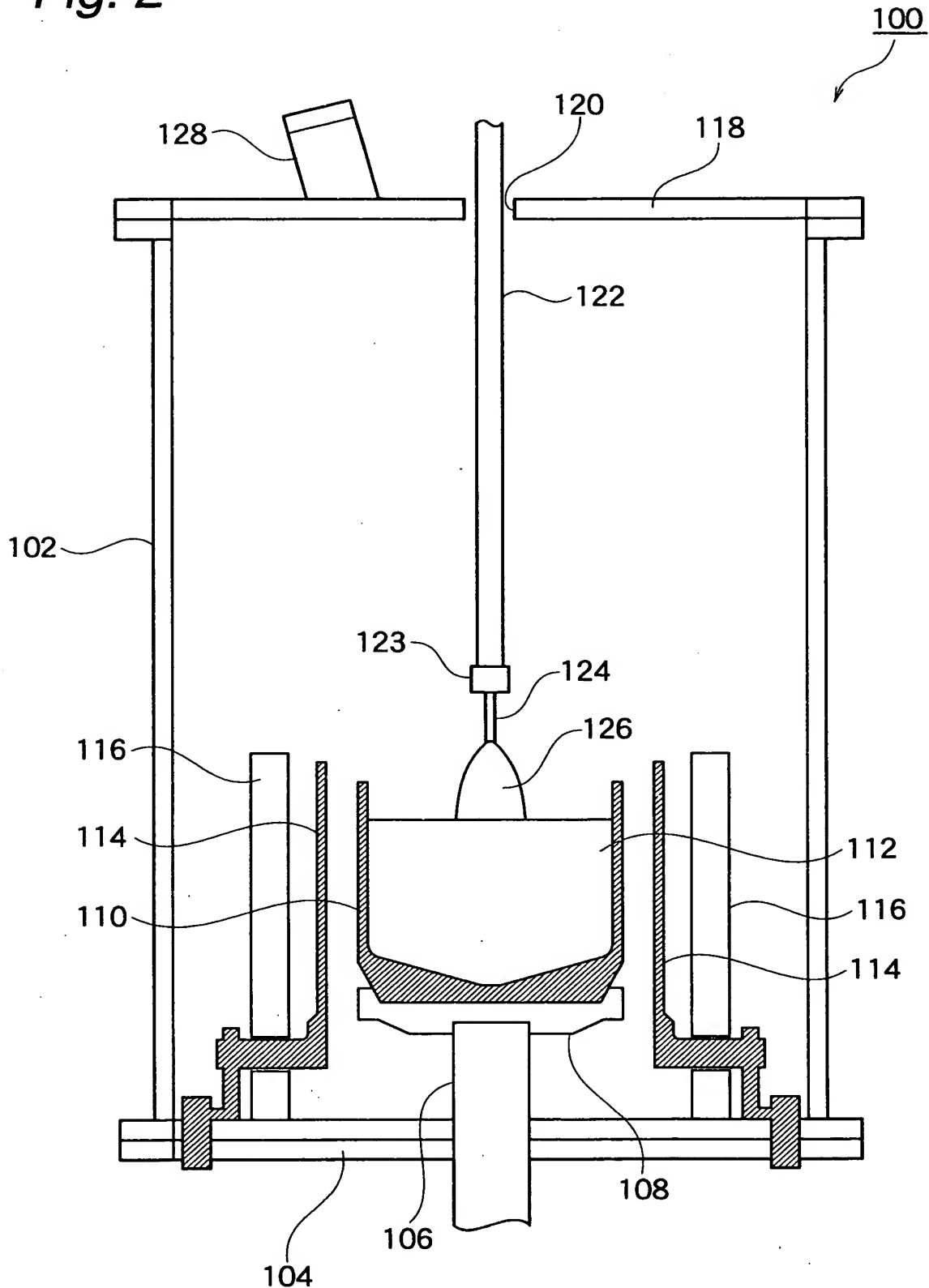
The attached sheets of drawings includes changes to Figures 2, 3 and 4. Figures 2, 3 and 4 have been amended to insert the legend --PRIOR ART--.

Attachments: Replacement Sheet

Annotated Copy Showing Changes

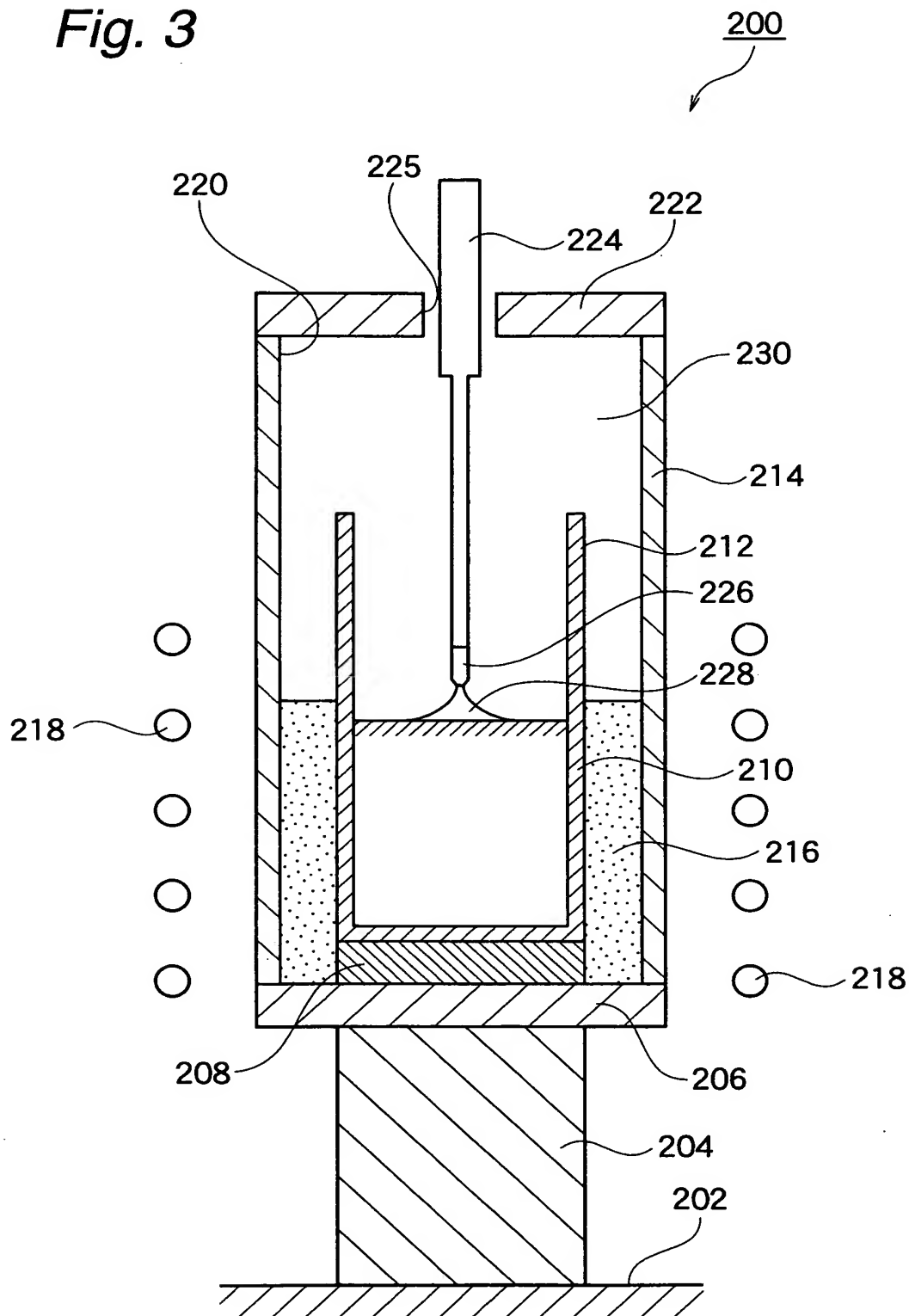


*Fig. 2*

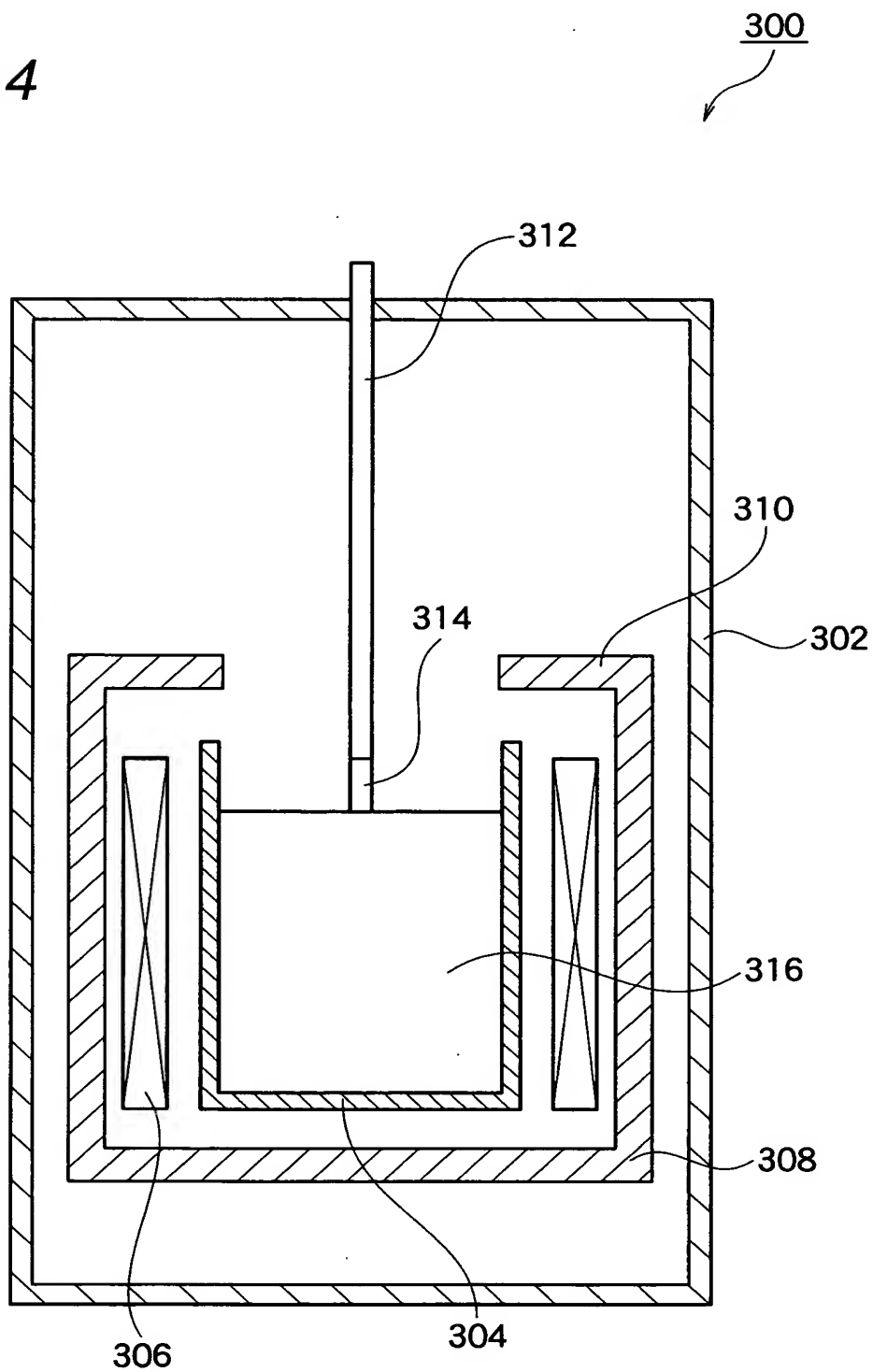


--PRIOR ART--

Fig. 3



--PRIOR ART--

*Fig. 4*

--PRIOR ART--